

ANALYSIS OF LOGISTICS AND SUPPLY CHAIN MANAGEMENT AGILITY IN CORRUGATED BOX INDUSTRY

Yosef Daryanto¹, Klaus Krämer²

¹Industrial Engineering Department, Universitas Atma Jaya Yogyakarta

²Department of Wood Technology, Hochschule Rosenheim, Germany
daryanto@mail.uajy.ac.id, klaus.kraemer@fh-rosenheim.de

Abstract

Several analyses were performed in this case study including the analysis of the business environments and the current supply chain system, which than followed by measurement and comparison of supply chain agility performance indicator. As corrugated box industry work in make/engineer to order system and by considering their competitive situation and uncertain business environment it was concluded that they need agility in their supply chain. The main problem was the unbalance power position with paper supplier that resulting low inbound inventory turns. Focusing on this weakness, two solutions were proposed; those are building higher collaboration with paper suppliers and performing better inventory management by set different inventory control and policy for each inventory class.

Keywords: *Corrugated box industry, performance indicator, supply chain agility.*

I. INTRODUCTION

Agility becomes one of the key success factors in today industry. Turbulent and volatile markets are becoming the norm as life-cycles shorten and global economic and competitive forces create additional uncertainty. According to Christopher (2000), to become more responsive to the needs of the market requires more than speed, it also requires a high level of maneuverability that today has come to be termed agility. Agility is all about creating customer responsiveness and mastering market turbulence/uncertainty and requires specific capabilities, on top of those that can be achieved using lean thinking (Van Hoek et al, 2001).

Parallel developments in the areas of agility and supply chain management led to the introduction of the agile supply chain concept to transfer the winning strategy of agility to supply chain as the newly accepted units of business and competition (Ismail and Sharifi, 2006). According to Industry Canada (2007), logistics and supply chain management agility has become one of the key performance indicators in today supply chain management.

The objectives of this research was first to explain the need of an agile supply chain management for the company in the case study based on their business environment and current supply chain system, secondly to measure and compare their agility performance to some of their competitors and standard, and finally propose ideas how to improve the supply chain agility performance. The subject in the case study is one independent corrugated box and fiberboard manufacturer in Indonesia. Located nearby the Indonesian capital, Jakarta, they supply corrugated box and fiberboard to other manufacturers in Indonesia and sometimes to companies abroad. Information from some competitors was gained through questionnaires.

II. LITERATURE REVIEW

A market-responsive or agile supply chain is needed for innovative product (Fisher, 1997), or when the market qualifiers are quality, cost, and lead time, and the market winner is service level (Mason-Jones et al, 2000). An agile supply chain is developed by the agility of the combination of supply chain segments of sourcing, manufacturing, and delivery (Prater, et al, 2001). Meanwhile, according to Swafford (2003) supply chain agility is positively influenced by the combinative effects of flexibility within the four supply chain functions: product development, procurement, manufacturing, and the logistics function.

Considering the scope of supply chain process that spans in plan, source, make, deliver, and return/reverse logistics categories (Supply Chain Council, 2006), supply chain agility is

here defined as the ability (responsiveness, competency, flexibility, and speed) of all supply chain elements (plan, source, make, and delivery including return/reverse logistics) to respond appropriately (align or reconfigure the network and its operations) to changes in an uncertain business environment. Agile supply chain requires capabilities of four main elements, those are responsiveness, competency, flexibility/adaptability, and quickness/speed (Lin et al, 2006), to rapidly align the network and its operations to the dynamic and turbulent requirements of the demand network (Ismail and Sharifi, 2006).

A number of characteristics that a supply chain must have in order to be truly agile are identified as follow (Christopher and Towill, 2001; Christopher, 2005; Iskanius, 2006; and Agarwal et al (2007):

- a. Market sensitive and responsiveness
- b. Information driven virtual integration
- c. Process integration
- d. Network based or collaboration

Furthermore, to create or enhance a company's supply chain agility, there are some proposed strategies, actions, proven ways or principles from several researches (Christopher, 2005; Lau and Hurley, 2001; Van Hoek et al, 2001; Lee, 2004; Ismail and Sharifi, 2006) as follow:

- a. Leveraging customer relationship
- b. Enhance market sensitiveness (to be demand driven and promote product customization)
- c. Leveraging supplier relationship
- d. Achieving strategic flexibility (flexible to uncertainty)
- e. Reducing complexity
- f. Build inventory buffers by maintaining a stockpile of inexpensive components that are often the cause of bottlenecks.
- g. Utilize appropriate performance metrics which can shapes agile behavior such as perfect order achievement and time to market.

Measurement of supply chain management key performance indicators is an essential part of the agile supply chain concept (Industry Canada, 2007). It is important for a company to understand the nature of its supply chain management operations. Key performance indicators (also called as metrics) allow the analysis of a system and comparison with a company's earlier performance, the rest of the industry, or other companies (Krauth et al., 2005). Measurement of supply chain management metrics has been discussed in several researches (Beamon, 1999; Gunasekaran et al, 2004; Lapide, 2006, etc). The important metrics also have been synthesized and developed by several organizations such as Supply Chain Council, PRTM, and Industry Canada.

III. RESEARCH METHODOLOGY

This research was a case study in an independent corrugated box and fiberboard manufacturer in Indonesia followed by benchmarking to some of their competitors. The analysis starts with an analysis of their business environment, production system and current supply chain system and relationship. According to Ismail and Sharifi (2006), in developing agile supply chain several key factors should be taking into account considering their impacts into the supply chain strategy:

- a. Market and business environment factors, such as market size, level of competitions, product life cycle in which the market is currently operating as well as the rate of new product introduction, customer involvement in specifying product specification/features, and business environment factors include legislative, economic, social, etc.
- b. Product factors, such as product complexity and level of technology, innovation involved in developing and manufacturing the product, and level of services involved in supporting the product from to distribution and after sales support.

- c. Company factors, predominantly concerned with the company's internal capabilities. These range from the ability to understand the dynamic nature and requirements of its markets to efficiently and effectively satisfying these requirements.
- d. Supply chain factors, such as suppliers' capability and availability, how it operates, its speed and level of effort required to set it up, align and maintain it, and level of communication required, level of trust, and balance of power.

In order to identify the collaboration and coordination profile in the relationship between the subject of case study and their paper suppliers and customers, qualitative analysis using a profile table that was adopted from Hieber (2002) were used.

The second analysis involved the analysis of the supply chain agility including the measurement and comparison of supply chain agility performance indicator to their competitors, and one standard from Industry Canada. Questionnaires were deployed to 45 corrugated box and fiberboard manufacturer in Indonesia to measure and inform their agility performance, but unfortunately only 4 were back. The metrics used to measure supply chain agility in this research were summarized from many publications from other researchers and chosen by aligning all the important performance indicators with the definition of supply chain agility in this research. The metrics used in this research are shown in Table 1. Finally, proposed ideas about how to improve the supply chain agility performance are synthesized focusing on the main weakness.

Table 1: Supply chain management agility metrics

Supply Chain Process Agility	Metrics
Plan Agility	Responsive planning time
	Order promising time
Source Agility	Procurement lead time
	Supplier flexibility
	Upside Procurement flexibility
	Inbound inventory turns
Make/Production Agility	New design time to order
	Upside production flexibility
Delivery Agility	Order fulfillment lead time
	Upside delivery flexibility
	Outbound inventory turns
Return Agility	Return order lead time

IV. RESULT AND DISCUSSION

This section provides all the founding during the research and the discussion about the ideas how to improve the supply chain agility performance.

A. Production system

Corrugated box is an industrial good. It tends to have a few raw materials, i.e. paper rolls, adhesive material, and ink, but produce many different designs of boxes and varied by many factors such as paper type and paper structure. Corrugated box is a customized product; one design is only useful for one customer, moreover for one customer's product or item. Its shape and dimension depends on the inside products' shape and dimension. Corrugated box is also usually printed in a design and color which indicate the inside product/products and the manufacturer. Therefore the variety of product handle or produce by a corrugated box manufacturer is huge. Make to order is then the common system in corrugated box manufacturing. As corrugated manufacturer works in a make to order system, the production processes are starting after customer order arrives. This actually needs speed and flexibility to react, adjusts, and executes different customer order.

The company in this case study was established in 2005. Currently it has around 300 employees that work in 2 shifts a day. In fulfilling customer order, there is a preliminary step called pre-order to prove the ability of manufacturer to produce the ordered product in the specified specification and design and to negotiate the price and other terms and conditions. This pre-order negotiation actually supports the company's ability to react, adjust, and execute different customer orders, but this agreement does not strongly tie both parties. No specific number of orders is agreed, which means the customer is still free to purchase their orders from other suppliers. The period of the agreement is also not specified. SKL is free to change the price any time, although in this case new negotiation is needed. This short agreement is usually valid in three months.

The production process of corrugated box is actually a mixture of continuous and discrete manufacturing. The routing of the production is relatively fixed except in finishing processes. This fixed sequence of main production processes with short manufacturing time enables the company to have flexibility to different customer orders.

B. Business environment

According to the International Corrugated Case Association (2007), for the forthcoming five years, corrugated output is expected to grow at an annual average rate of 4%, and corrugated box manufacturers are facing tough challenges ahead, characterized by increasingly stronger competition due to overcapacity, increasingly higher customers' expectations and increasingly higher production costs (Ming et al, 2004). Customers expect for a better design with more complicated shapes and more colorful and sophisticated printing requirements, and smaller order sizes and/or just-in-time delivery.

In 2005, the production of Indonesian corrugated cardboard industry is around 2,172 million square meters. Figure 1 shows the Indonesian corrugated production among other Asian countries (Asian Corrugated Case Association, 2007). According to the Indonesian association of corrugated cardboard industry (PICCI) the production of corrugated box in Indonesia increases in average 4% per year, but there is over capacity compared to the overall demand from consumer goods manufacturers, therefore competition in this industry is tough and customers can easily move to other corrugated box manufacturers.

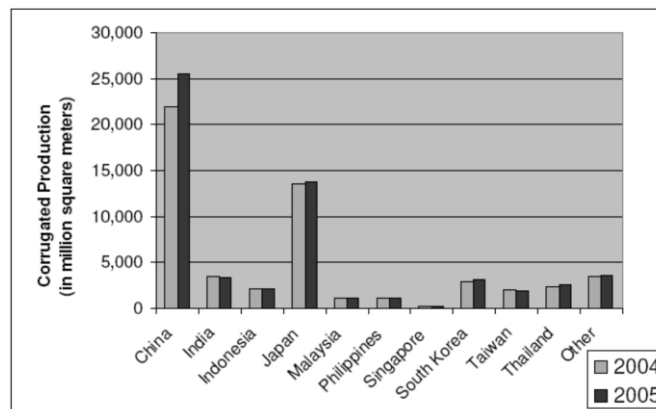


Figure 1: Indonesia corrugated production among other Asian countries (Asian Corrugated Case Association, 2007)

C. Current supply chain system

Figure 2 shows the supply chain of the subject of case study. They have several suppliers such as paper manufacturer, ink, printing plate, and tapioca flour suppliers. The customers are consumer goods manufacturers and also some converting industries that buy corrugated sheet and then convert them into others products. There are also some transportation partners that distribute the products to the customers.

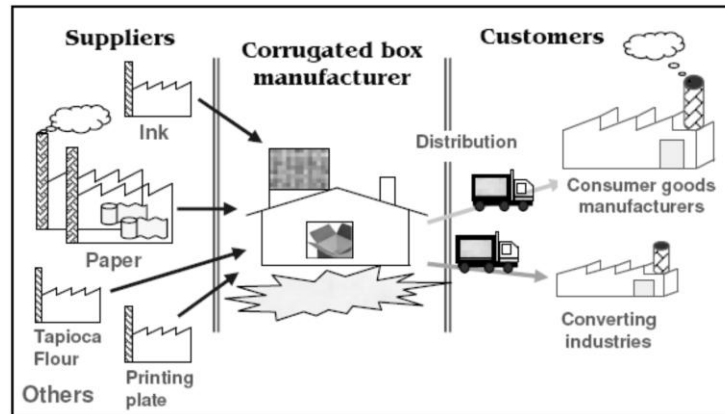


Figure 2: Supply chain and flow of material in corrugated box manufacturer

Collaboration-related feature			
Orientation of business relations	Cooperation oriented		Competition oriented
Mutual trust and openness	High		Low
Balance of power	High dependancy		Equal
Coordination-related feature			
Intensity of information sharing	Low		High
Degree of communication	Single contact		Multiple contacts
Variability of consumption	Low/stable		High
Use of information technology (IT)	IT use only for supporting internal business process		IT use to support planning and execution in network

Figure 3: Qualitative collaboration and coordination profile with paper supplier

Around 75 – 90% of corrugated box production cost is from the paper cost; therefore strategic partnership with paper supplier is very important. The demand for this paper is mainly fulfilled by local supplier (around 90%), and 10% from import such as from China, New Zealand, and Canada. Currently they only have 2 local paper supplier and contact to some paper importer. Unfortunately, from the analysis it was

found that collaboration and coordination with their paper supplier is very weak. Figure 3 shows the collaboration and coordination profile between subject of case study and their paper suppliers (adopted from Hieber, 2002) according to the Director of Administration of the company.

Corrugated box manufacturer is too dependent to paper supplier. For all their purchase order, company can not determine the delivery date, frequency of delivery, and the number of paper roll in each delivery. There are limited corrugated box paper suppliers in Indonesia with varied quality level. Paper supplier is usually bigger in size and economic scale, and they prefer to sell their product to global market that has higher price than local market.

Closer supplier relationship is developed in supply and inventory function for the need of ink. The need for ink is fulfilled only from one supplier. The company provides one area in their plant for the supplier to stock their ink inventories. Outsourcing practices of ink inventory and warehousing, printing plate production, and product distribution support the agility. These practices ensure the availability of ink in economic level, fast and economic design and production of printing plate, and also flexible and quick delivery of customer order.

Giving the best service and relationship to the customer is the strategy of the company. One of the implementation is by selecting and maintaining only the highly beneficial customer. Figure 4 show the collaboration and coordination profile between subject of case study and their customers according to the Director of Administration of the company. Pre-order process and negotiation indicate better coordination with customers, but they still have low collaboration indicate by low information sharing and limited communication contacts. In general all parties try to build mutual relationship with balance of power.

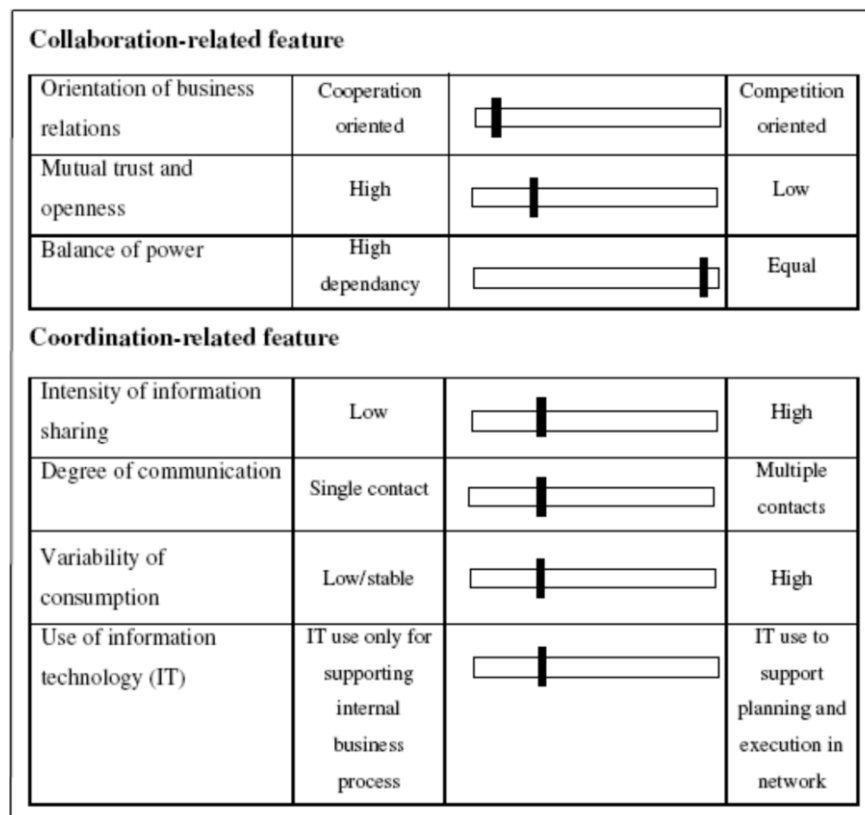


Figure 4: Qualitative collaboration and coordination profile with customers

Telephone, fax, and email are the information and communication technology used for information sharing and communication with their suppliers, customers, and other partners. Internally the company using Corrugated Packaging System (CPS), an Enterprise Resource Planning (ERP) system for corrugated box industry that integrates the information sharing throughout the system in the company.

D. Supply chain agility performance

Supply chain management agility metrics discussed in Section 3 were used to measure the supply chain agility performance of the case study subject and three (3) of their competitors. The result is shown in Table 2 and is used for benchmarking purpose. It can be seen that there is no differences in case of plan agility between all the manufacturers. But, in general the subject of this case study has better agility performance in case of source and production agility. The entire plus and minus of supply chain system developed by the company resulting better agility performance except the upside procurement flexibility and outbound inventory turns, meanwhile the return agility is not much different.

Table 2: Supply chain agility performance of four corrugated box manufacturers

Performance Indicator	Company A	Company B	Company C	Subject of Case Study
Plan Agility				
Responsive planning time	1 day	1 day	1 day	1 day
Order promising time	1 day	1 day	1 day	1 day
Source Agility				
Procurement lead time	60 days	30 days	21 days	14 days
Supplier flexibility	7 days	14 days	10 days	1 day
Upside Procurement flexibility	60 days	30 days	17 days	29.18 days
Inbound inventory turns	-	4.28	8.64	9.56
Production Agility				
New design time to order	4 days	7 days	5 days	4 days
Upside production flexibility	1 days	7 days	5 days	1 days
Delivery Agility				
Order fulfillment lead time	6 days	5 days	5 days	5 days
Upside delivery flexibility	2 days	7 days	4 days	1 day
Outbound inventory turns	-	103.02	121.11	79.6
Return Agility				
Return order lead time	2 days	3 days	4 days	3 days

According to Industry Canada (2006), the main key performance indicator for evaluating supply chain agility is inventory turns. In order to get clearer visibility about supply chain agility performance, the inventory turns are then being compared. The result is shown in Table 3.

Table 3: Comparison of inventory turns with Industry Canada standard

Performance Indicator	Company A	Company B	Company C	Subject of Case Study	Industry Canada
Inbound inventory turns	-	4.28	8.64	9.56	25.7
Outbound inventory turns	-	103.02	121.11	79.6	32.1

It was clear that problem occurs in inbound inventory turns. Indonesian corrugated box manufacturers have lower inbound inventory turns compared to Canadian manufacturers. Lower inbound inventory turns means raw material (paper) is stocked in longer time or they stock more raw materials in their warehouse in comparison with their production quantity. Availability of raw material and the lead time and also level of collaboration and integration with supplier may cause this difference. What can we get from this comparison is that they have to increase the inbound inventory turn.

According to Industry Canada (2006), the fact of a low supply chain agility factor in terms of raw material inventory management could be linked with the level of collaboration with suppliers. In order to dramatically increase the velocity of inbound goods, firms must develop in depth sourcing processes that are linked with their suppliers and customers. Leveraging supplier relationship is one action to create or enhance a company's supply chain agility (Christopher, 2005; Lau and Hurley, 2001; Van Hoek et al, 2001; Lee, 2004; Ismail and Sharifi, 2006). Therefore possible solution the company can tried in order to increase their inbound inventory turns is develop collaboration with suppliers and customers. Close collaboration and sharing of information with suppliers, and also with their customers enable a better planning and scheduling of production and distribution.

There are about 6 alternatives of paper supplier for the company which 2 of them are relatively close in distance. They need to assess the possibilities to collaborate to these suppliers. A set of selection criteria will then be needed. The size of these suppliers is smaller than their current suppliers, so that a better bargaining power and collaboration is more realistic. Assistantship and other collaboration may be required to increase total performance. Finding new alternative supplier which can fulfill company requirement and standard will also beneficial to increase the supplier flexibility.

Better inventory management can be an internal solution in order to increase inbound inventory turns. This solution will be important especially before the collaboration program being realized. ABC and XYZ analysis and classification can be one solution. The company can than define appropriate policy for optimizing their inventory such as safety stock policy and inventory controlling system for different class.

Table 4 shows the result of ABC and XYZ classification of paper used in the subject of case study. The ABC classification is based on percent of consumption and XYZ classification is based on variation coefficient. For A-class items (i.e. 38 paper types) higher attention by daily review is need to be given. The company also must find and keep alternative supplier for these items. For B-class items (i.e. 49 paper types) alternative suppliers also important to be found but inventory review can be performed in weakly interval. Therefore A and B class items need to be considered in finding new supplier. In managing C-class items (89 paper types), efficient effort by monthly planning is required as they have less value.

Based on XYZ classification, the company can set different safety stock policy for different inventory class. Because Z-class item is more difficult to forecast, it needs a higher safety stock. For CZ-class items, because they have low value but require higher attention since they more fluctuate, it would be better to accumulate and/or substitute the CZ-items (i.e. 56 paper types) by the same paper type with bigger dimension and belongs to A or B class. It will be less efficient in number of scraped paper but more efficient in reducing inventory and effort due to less complexity.

V. CONCLUSION

In developing responsiveness, competency, flexibility, and speed of all supply chain elements in order to achieve supply chain agility, higher level of collaboration and coordination is one important factor. Unfortunately characteristic and structure of supply

chain partner's industry can be barriers for this effort. Unbalance power position with main supplier, resulting lower inbound inventory turns for Indonesian corrugated box industry. A long time effort of building higher collaboration and information integration can be started by assessing new alternative paper suppliers. Internally, company can start the effort by improving its inventory management.

Table 4: ABC and XYZ classification of paper used in the company

ABC Classification by % Consumption	XYZ Classification by Variation Coefficient			
		X	Y	Z
	A	M18, M12, M15, M22	M17, K61, M16, M14,M13, K42, K43, M19, K62, K39, K36, K38, K60, M09, K41, M11, K52, M10, M04, M38, M06, M40, K40, K18, K34, K44, M08, K12, K37, M39, M43, M20	M42, K76
	B		M21, M30, M41, M02, M36, M05, M07, M35, M37, M32, K59, K31, K17, K57, M01, M44, K15, M34, M03, K56, K58, K29, K16, K66, K30, K63, K55, K26, K54, K32, M31, K19, K33, K65, K27, K53, K35, K22, K28, K78, K48, K11, K83, W14, K06	W20, K14, K49, K64
	C	K03	M26, K24, K21, K45, M27, K10, K09, K13, K08, K25, K04, M33, K02, W13, K20, K50, K07, K47, K23, M23, K05, M29, M24, K79, K01, K46, K86, M25, K82, K81, K70, K72	M28, K51, K67, K68, K69, K71, K73, K74, K75, K77, K80, K84, K85, K87, K88, W01, W02, W03, W04, W05, W06, W07, W08,W09, W10, W11, W12, W15, W16, W17, W18, W19, W21, W22, W23, W24, W25, W26, W27, W28, W29, W30, W31, W32, W33, W34, W35, W36, W37, W38, W39, W40, W41, W42, W43, W44

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